APPENDIX 12

AN EVALUATION OF CHANGES IN TERRESTRIAL HABITATS RESULTING FROM THE YAZOO BACKWATER PROJECT, MISSISSIPPI

AN EVALUATION OF CHANGES IN TERRESTRIAL HABITATS RESULTING FROM THE YAZOO BACKWATER PROJECT, MISSISSIPPI

by

James S. Wakeley

Environmental Laboratory

DEPARTMENT OF THE ARMY
Corps of Engineers Research and Development Center
Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

3 March 2000

Prepared for:

US Army Engineer District, Vicksburg
Vicksburg, MS 39180-5191

CONTENTS

PREFACE

The US Army Engineer District, Vicksburg (CEMVK), has been authorized to provide flood protection through a series of projects in the Yazoo River Basin in northwestern Mississippi. This report contains an analysis of impacts to habitats for terrestrial wildlife resulting from one component of the work, the Yazoo Backwater Project. The report contains an analysis of project alternatives, many of which include features designed to increase habitat availability for selected wildlife species.

This work involved the use of the US Fish and Wildlife Service (FWS) Habitat Evaluation Procedures (HEP), and was accomplished in cooperation with the terrestrial HEP Team: Messrs. Ken Quackenbush, FWS; Don Brazil, Mississippi Department of Wildlife, Fisheries, and Parks; and Gary Young, CEMVK. Many of the data upon which this analysis was based were provided by Messrs. Gary Young, Marty Garton, Charlie McKinnie, and others at CEMVK. Mr. Dwayne Templet and others from Geo-Marine, Inc., accomplished the field work.

During the conduct of this study, Dr. Morris Mauney was Chief of the Wetlands Branch at the US Army Engineer Research and Development Center (ERDC) Waterways Experiment Station (WES); Dr. Conrad J. Kirby was Chief, Ecological Research Division; and Dr. John Keeley was Acting Director, Environmental Laboratory.

COL Robin R. Cababa was Commander of ERDC and Acting Director of WES.

ABSTRACT

The US Fish and Wildlife Service Habitat Evaluation Procedures (HEP) were used to quantify anticipated impacts and benefits of the Yazoo Backwater Project (YBP) to terrestrial wildlife habitats in northwestern Mississippi. Six evaluation species — barred owl, gray squirrel, Carolina chickadee, pileated woodpecker, wood duck, and mink — were used to represent the habitat requirements of wildlife inhabiting the forested portions of the study area. The quality of habitat for each species was determined by measuring specific habitat variables (e.g., canopy cover, tree height, size and abundance of snags) on sample plots and entering these data into Habitat Suitability Index (HSI) models for each species. HSI scores can range from 0 (unsuitable habitat) to 1.0 (optimal habitat). Hydrologic information required by the models was provided by the Vicksburg District, US Army Corps of Engineers.

The study area consisted of the four designated reaches of the YBP in Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo Counties, Mississippi, and Madison Parish, Louisiana. Impacts and benefits were estimated for 35 alternative project plans, including one levee alternative, two non-structural alternatives, and 32 alternatives consisting of different combinations of pump sizes, water management options, and reforestation designs. Separate analyses were done for each project reach and alternative plan.

Baseline (pre-project) HSI values indicated better-than-average habitat quality for most evaluation species. HSIs for different project reaches ranged from 0.70-0.91 for barred owls, 0.58-0.64 for gray squirrels, 0.63-0.76 for Carolina chickadees, 0.73-0.93 for pileated woodpeckers, 0.41-0.58 for wood ducks, and 0.12-0.13 for mink. HSIs for the first four species are applicable to all forested acreage in a reach. The HSI for wood ducks applies only to forest that is flooded continuously during the brood-rearing period, assumed to be March through May in this area. The HSI for mink applies only to areas of potential mink habitat, defined as forest land that is flooded at least 25% of the year (cumulative duration). The very low HSIs for mink were due to average annual flooding durations on these lands that barely exceeded the 25% minimum.

Impacts or benefits of each project plan were determined by calculating the net change in Average Annual Habitat Units (AAHU) between the no-action alternative and the 35 with-project alternatives for each evaluation species. Twelve alternatives (Plans 3, 4, 5, 9, 15, 16, 17, 21, 27, 28, 29, and 30) resulted in overall net losses of wildlife habitat ranging from –876 to – 7,957 AAHU for the six evaluation species combined. None of these plans had a reforestation component. All other alternatives resulted in overall habitat gains, although in some plans (Plans 10, 11, 22, and 23) a loss of habitat for wood ducks was more than balanced by a gain of habitat for mink. Plans that included reforestation of existing cleared lands (Plans 2, 6, 7, 8, 12, 13, 14, 18, 19, 20, 24, 25, 26, 31, 32, 33, 34, and 35) increased habitat availability for all six evaluation species. Total AAHU benefits of plans involving reforestation ranged from nearly 73,000 AAHU for Plan 18 to over 181,000 AAHU for Plan 34.

AN EVALUATION OF CHANGES IN TERRESTRIAL HABITATS RESULTING FROM THE YAZOO BACKWATER PROJECT, MISSISSIPPI

PART I: INTRODUCTION

Background and Objectives

This report is the sixth in a series of studies of the potential impacts and benefits to terrestrial wildlife habitats of the reformulated Yazoo Basin flood control projects in northwestern Mississippi. Previous reports addressed the Steele Bayou project (Wakeley and Marchi 1991), maintenance and operation of reservoir outlet channels (Wakeley 1991), the Upper Yazoo Project (Wakeley and Marchi 1992), the Big Sunflower Maintenance Project (Wakeley 1995), and the Mississippi Delta Project (Wakeley 1996).

As in the previous analyses, the Habitat Evaluation Procedures (HEP) (US Fish and Wildlife Service 1980a, b) were used to quantify the potential impacts and benefits of various project alternatives to terrestrial wildlife species inhabiting forested habitats in the Yazoo Backwater Project (YBP) area. HEP is a habitat-based evaluation system that allows one to estimate current habitat conditions, predict future conditions, compare project alternatives, and devise mitigation strategies, all without the need for direct sampling of animal populations.

The objectives of this work were (1) to determine baseline (pre-project) habitat suitability for selected wildlife species in the YBP study area, and (2) to estimate changes in habitat availability for each species under each project plan. The YBP differed from previous projects in the Yazoo Basin in that design features intended to benefit wildlife species were an integral part of most alternative plans. Therefore, the purpose of this study was to evaluate the overall effects of each plan on wildlife habitat, rather than making separate evaluations of project impacts and mitigation requirements.

An Overview of HEP

HEP is an accounting system for quantifying and displaying habitat availability for fish and wildlife. HEP is based on habitat suitability index (HSI) models that quantitatively describe the habitat requirements of a species or group of species. HSI models use measurements of appropriate variables to rate the habitat on a scale of zero (unsuitable) to 1.0 (optimal). In a typical HEP study, a number of evaluation species are chosen for each cover type of interest in the study area. Species may be chosen because of their ecological, recreational, or economic value, or because they represent groups of species (i.e., guilds) that have similar habitat needs (Roberts and O'Neil 1985).

After cover types in the study area have been mapped and evaluation species have been selected, habitat variables contained in the HSI models for each species are measured from maps, aerial photographs, or by onsite sampling. HSI values are then calculated, and the initial or baseline number of habitat units (HUs) is determined for each species. One HU is equivalent to 1 acre of optimal habitat; therefore, the number of HUs for a species is calculated as the number of acres of available habitat times its suitability (HU = HSI H acres).

HUs available to each species are estimated for each of several target years (TYs) over the life of the project (generally 50 years). Estimates of future habitat conditions are made for the "without project" alternative and for each "with project" alternative. Impacts or benefits to each species are then determined by calculating the difference in average annual habitat units (AAHUs) between with-project and without-project alternatives. (The preceding information was adapted from Wakeley and O'Neil 1988).

PART II: STUDY AREA AND METHODS

The HEP Team

The function of a "HEP Team" is to guide the evaluation, monitor its progress, examine intermediate results, and make changes in direction, if needed. The terrestrial HEP Team for the Yazoo Backwater Project consisted of Mr. Ken Quackenbush (US Fish and Wildlife Service) (FWS), Mr. Don Brazil (Mississippi Department of Wildlife, Fisheries, and Parks) (MDWFP), and Mr. Gary Young (US Army Corps of Engineers, Vicksburg District) (CEMVK). Other participants in HEP Team meetings included Messrs. Steve Reed, Charlie McKinney, and Marty Garton (CEMVK), and Mr. Dwayne Templet of Geo-Marine, Inc.

Study Area

The study area consisted of the four designated reaches of the YBP in Humphreys, Issaquena, Sharkey, Warren, Washington, and Yazoo Counties, Mississippi, and Madison Parish, Louisiana. Large portions of the area are subject to backwater flooding from Steele Bayou, Deer Creek, and the Big and Little Sunflower Rivers at times when Mississippi River levels are high and drainage through the Steele Bayou structure is not possible.

Project Alternatives

Alternative project plans are described in the main report and are summarized briefly here (Table 1). Most plans involve structural (i.e., pump or levee), non-structural (i.e., easements with or without reforestation), and environmental (i.e., water management) design features. The 35 plans represent different combinations of features. Plans 1 and 2 are completely non-structural alternatives, with and without a reforestation component. Plan 29 involves the construction of levees along both sides of the Sunflower River system. The levees would restore the historical separation between the Sunflower and Steele Bayou drainages that was breached in 1978 with the construction of the connecting channel. This alternative would decrease flood stages in the Steele Bayou sump area, but increase stages in Reach 4.

All other plans involve installation and maintenance of a pump to evacuate flood water over the main levee at Steele Bayou. The plans differ in pump capacity (i.e., 14,000 or 17,500 cubic feet per second (cfs)), target water elevation for pump operation (i.e., 80, 85, 87, 88.5, or 91 ft NGVD), and non-structural features (i.e., preservation of existing woodlands and/or reforestation of existing cleared lands below a specified elevation) (Table 1).

In addition, most plans involve water management that will retain water in forested areas during specified periods of the year. For example, eight plans would maintain water levels below 80 ft NGVD from 1 December to 1 March. Eight more plans would maintain water levels below 85 ft from 1 January to 15 February, and 80 ft from 1 December to 1 January and 15 February to 1 March. Six plans would maintain 70 to 73-ft levels during low-water periods and two of these would reintroduce Mississippi River flows up to 87 ft (Table 1).

Potential effects of each project plan on the availability of wildlife habitat were determined by comparing each plan against a no-action alternative (i.e., the continuation of existing conditions). Most plans would result in changes in flooding frequency and duration over wide areas, with potential consequences for water-dependent wildlife species. Furthermore, plans involving clearing of existing woodlands (Plan 29, the levee plan, only) or reforestation of existing open lands (several alternatives) would result in changes in habitat availability for many forest-dwelling species.

Cover Types

The YBP area consists largely of agricultural land containing scattered remnants of the original bottomland hardwood and cypress/tupelo forests. Two of the largest remaining blocks of forest in the study area are the Delta National Forest and adjacent forest lands in Reach 3 and the Mahannah area at the southern end of Reach 1.

Agricultural areas in the YBP were considered to have little value as wildlife habitat, except for fields that are flooded during the winter and attract large numbers of waterfowl (see the separate analysis of project impacts and benefits for wintering waterfowl). Therefore, the terrestrial habitat evaluation was limited to forested habitats.

Land cover information for the study area was provided by the Vicksburg District based on interpretation of satellite data; spatial data were stored and manipulated in a Geographic Information System (GIS). The GIS indicated a total of more than 257,000 acres of forest lands in the study area, not counting tracts <10 acres in size. There were approximately 112,500 acres in Reach 1, 20,800 acres in Reach 2, 77,800 acres in Reach 3, and 46,000 acres in Reach 4.

According to the GIS, more than 85% of forest acreage in the YBP was in bottomland hardwoods (BLH) with the remainder in cypress/tupelo stands. When examined on the ground, cypress/tupelo stands rarely were large enough or stocked densely enough to sample. Many stands were no more than narrow fringes along creek and lake margins. Other cypress/tupelo stands indicated in the GIS did not exist on the ground but were due to errors in classification of satellite imagery. Because of these problems, cypress/tupelo could not be dealt with as a separate cover type in the HEP analysis. Therefore, BLH and cypress/tupelo were combined into a single "forested" cover type and the wildlife value of each component was assumed to be the same.

Evaluation Species

HEP Team members met in May 1994 to discuss potential evaluation species. To maintain consistency with the previous components of the Yazoo Basin flood control projects, the Team agreed to use the same six evaluation species used in previous studies (Wakeley and Marchi 1991, Wakeley 1991, Wakeley and Marchi 1992, Wakeley 1995, Wakeley 1996). The Team also agreed to evaluate the possible addition of more water-dependent species. Team members reviewed published models for the beaver (*Castor canadensis*), bullfrog (*Rana catesbeiana*), slider turtle (*Pseudemys scripta*), and swamp rabbit (*Sylvilagus aquaticus*). The consensus was that these additional species models were not appropriate or added little additional information to the analysis.

Species used in the YBP analysis were selected to reflect the wildlife values of the relatively mature forests existing in the basin. Four species — barred owl (*Strix varia*), gray squirrel (*Sciurus carolinensis*), Carolina chickadee (*Parus carolinensis*), and pileated woodpecker (*Dryocopus pileatus*) — inhabit upland forests and forested wetlands. Barred owls and pileated woodpeckers prefer mature forests with closed canopies and large trees. Woodpeckers excavate nesting cavities in live trees or snags, and owls use pre-existing cavities. Carolina chickadees nest in small cavities and forage in closed forests with abundant tree foliage. Gray squirrels prefer mature forest with dense understory vegetation and abundant mast-bearing trees such as oaks and hickories.

The remaining two species — wood duck (*Aix sponsa*) and mink (*Mustela vison*) — also inhabit forested areas but require the presence of surface water for at least part of the year. Wood ducks build their nests in large cavities in live trees or snags, or will use artificial nest boxes, if present. Brood-rearing habitat consists of areas that are flooded continuously during spring and have abundant cover near the water's surface. Mink inhabit wooded swamps and upland forests adjacent to lakes and streams. Much of their diet consists of fish and aquatic invertebrates, although they also capture birds, small mammals, reptiles, and amphibians.

Habitat Suitability Index Models

Published HSI models were available for five of the evaluation species — barred owl (Allen 1987a), gray squirrel (Allen 1987b), pileated woodpecker (Schroeder 1983a), wood duck (Sousa and Farmer 1983), and mink (Allen 1986). The wood duck model contained two parts, a breeding model and a wintering model. Only the breeding model was used in this analysis. For the mink, only the version of the model for palustrine forested wetlands was appropriate to the study area and to the kinds of impacts anticipated in this project. A model for the Carolina chickadee was developed for this study by Rick Schroeder (US Geological Survey, Biological Resources Division (BRD), Fort Collins, CO; letter from Adrian Farmer, BRD, to Robert Barkley, USFWS, Vicksburg, MS, dated 29 October 1989). The model was based on an existing HSI model for the black-capped chickadee (*Parus atricapillus*) (Schroeder 1983b). Habitat variables used in the six HSI models are listed in Table 2.

With the concurrence of the original Steele Bayou Project HEP Team, minor modifications were made in some models to correct errors in the original published versions or to tailor the models to conditions expected in the Yazoo Basin (Wakeley and Marchi 1991). Furthermore, conventions regarding minimum suitable tract size and juxtaposition of habitat types developed for the Steele Bayou study (Wakeley and Marchi 1991) were followed in the YBP analysis. In general, habitat variables were measured in forested tracts $\exists$10 acres in size but results were applied to all stands $\exists$1 acre. It was assumed that forest tracts in this study area were in close enough proximity, and sufficient corridors for animal movements existed (e.g., along stream and ditch banks), that no species was limited by small tract size. In applying the wood duck model, it was assumed that flooded forests provided both nesting sites (i.e., tree cavities) and brood-rearing habitat, eliminating the need to consider juxtaposition of habitat types that provided only one but not both life requisites.

Selection of Tracts to Sample

HEP analyses were performed separately for each project reach. Therefore, the sampling scheme was designed to determine average habitat suitability of forested tracts within a reach.

Tracts to be sampled in each reach were selected according to procedures developed in previous studies (e.g., Wakeley and Marchi 1991, 1992). Maps showing the locations of forest stands in each reach were produced by CEMVK on the GIS at a scale of 1:62,500. Individual forest tracts were circled and numbered consecutively. For sampling purposes, tracts were defined as blocks of forest at least 10 acres in size separated from other such blocks by at least 25 m. Some large tracts were subjectively divided at major constrictions and the parts numbered separately.

To identify tracts to sample, tract numbers were selected from a table of random numbers. In the field, the sampling teams had the prerogative to drop a tract from the sampling list if (1) it did not meet the Society of American Foresters definition of a forest (i.e., at least 25% canopy cover of trees), (2) it was highly urbanized, (3) it was a linear stand less than 328 ft wide, or (4) permission for access could not be obtained. In such cases, an additional randomly selected tract in that reach was substituted. Eight tracts were sampled during 1995 in Reach 1, ten in Reach 2, eight in Reach 3, and ten in Reach 4.

In addition, sample sizes were augmented with data from several tracts sampled in previous Yazoo Basin studies that fell within YBP reach boundaries. Data from eight tracts sampled in 1990 during the Steele Bayou Project were included in Reach 1, and data from four tracts sampled in 1993 during the Big Sunflower Maintenance Project were added to Reach 3.

Estimating Habitat Variables and Affected Acres

Sampling Teams

Habitat variables contained in the HSI models were measured during August and September 1994 by sampling teams from Geo-Marine, Inc., Baton Rouge, LA. Some of the field personnel had also participated in previous Yazoo Basin field studies, insuring consistency in data collection.

Number and Location of Plots

As in previous studies, habitat variables were measured within nested 0.1 and 0.2-acre circular sampling plots established at intervals along one or more transects in each selected forest tract. Whenever possible, transect starting points and directions were determined by stopping at a randomly selected point along a road or accessible edge of the tract, and using the topographic map to determine a compass bearing along the expected moisture gradient. This sampling scheme was designed to (1) include the range of moisture conditions in the tract, (2) include both BLH and cypress stands, if present, and (3) include any areas that typically contain standing water. If the tract was large or heterogeneous, one or more additional transects were established; however, most tracts contained only one transect.

The center of the first sampling plot was established approximately 300 ft from the edge of the tract and subsequent plots generally were located at 300-ft intervals. Teams were free to modify plot spacing to adapt the sampling design to the site. Sampling continued until, in the sampling team's judgment, a sufficient number of plots had been sampled to characterize average conditions in the tract. Sampling teams were directed to sample at least three plots in each cover type, but to continue sampling if tracts were heterogeneous or changing along the gradient. Whenever the transect encountered a stream or lake, at least one additional plot was established at the water's edge to estimate certain variables used in the wood duck and mink models.

In all, 152 plots were used in the analysis, including those from previous studies. Forty nine plots were sampled in Reach 1, 30 in Reach 2, 39 in Reach 3, and 34 in Reach 4.

Plot Sampling

Habitat variables (Table 2) were either estimated directly or calculated later from data collected in the field. Unless otherwise specified, all data were collected on a 37-ft radius (0.1-acre) plot.

The tree layer consisted of all woody plants >20 ft tall, excluding vines. Trees rooted in the plot were classified visually as either overstory (at least 80% of the height of the tallest tree) or understory, and identified to species. The diameter at breast height (DBH) of each tree was measured to the nearest inch, and the average height of all trees (TREEHT) was estimated visually and checked occasionally with a clinometer. Tree counts and DBH measurements were used to calculate the mean DBH of overstory trees (MEANDBH), density of trees >20 inches DBH (DENTR20), and the number of hard mast species ∃10 inches DBH (MASTSPEC). Oaks (*Quercus* spp.) and hickories (*Carya* spp.) were the only hard-mast genera in the study area.

To improve the accuracy and consistency of visual estimates of percent cover, each member of a sampling team would make an independent estimate, compare estimates with other team members, and arrive at a consensus. Percent cover was estimated separately for all trees (TREECOV), overstory trees (OVERCOV), emergent herbaceous vegetation (EMERGCOV), and potential wood duck brood cover (BROODCOV). The last two variables were measured at inundated or shoreline plots only. In addition, the proportion of tree canopy cover that consisted of hard-mast producers (MASTPROP), was calculated from TREECOV and an estimate of the canopy cover of hard-mast species ∃10 inches DBH.

The shrub layer consisted of woody plants 3-20 ft tall, including vines. Estimates were made of the percent cover of shrubs (SHRUBCOV) and of trees and shrubs combined (SHTRCOV).

The following data were collected within a 53-ft radius (0.2-acre) plot. STUMPLOG was the combined number of tree stumps (>1 ft tall and >7 inches in diameter) and logs (>7 inches in diameter at the large end and >3 ft long) in the plot. CAVITY was the number of living trees with cavities >1 inch in diameter, found in the trunk or limbs >4 inches in diameter. WDCAVITY was the number of cavities at least 3 by 4 inches found in trees or snags ∃6 ft above the ground, and WDBOXES was a count of maintained and predator-proof nesting boxes designed for wood ducks.

Snags were defined as standing dead trees >4 inches in diameter and ∃6 ft tall, including live trees from which >50% of the branches had fallen or were present but no longer produced foliage. DBH measurements of all snags in the plot were used to calculate the density of snags >4 inches DBH (DENSN4), density of snags >15 inches DBH (DENSN15), mean DBH of snags >15 inches DBH (AVGSN15), and the combined density of trees and snags >20 inches DBH (TRSN20).

Affected Acres and Other Habitat Variables

The site for the proposed backwater pump had already been cleared and prepared as part of a previous project. Therefore, the only direct construction impacts to forested lands associated with the YBP

were those due to levee construction under Plan 29. Wherever possible, levees would be located on existing cleared land. However, CEMVK estimated that 400 acres of forest would have to be cleared in Reach 2 and 370 acres in Reach 4 to build the levees.

The wood duck HSI model was applied only to areas that were potential brood habitat, defined as forest that is flooded continuously every year during the brood-rearing period (assumed to be March through May). Estimates of the average number of acres of wood duck brood habitat in each reach under each project plan were provided by CEMVK (Table 3).

The mink model for forested wetlands required estimates of the number of acres of forest that have surface water present for at least 25% of the year (cumulative duration) at 2-year frequency, plus estimates of the average flooding duration (PCTYEAR) in those areas. CEMVK hydraulics staff provided the estimates for each reach under existing conditions and under each proposed project plan (Table 4).

Calculating Baseline Habitat Conditions

The Statistical Analysis System (SAS) (SAS Institute, Inc. 1985) was used to calculate habitat variables from field data for each sampled plot. For most variables, plot values were first averaged within tracts and tract means were then averaged within reaches. Standard errors, reflecting among-tract variance, were calculated for each variable. This procedure gave equal weight to the tracts in calculation of reach means regardless of tract size; however, tract sizes had often been determined arbitrarily by splitting larger tracts to make sampling more efficient.

Averaging the number of hard-mast species (MASTSPEC) across plots underestimated the total number of mast species in a tract. Therefore, tract values were determined by counting species that were tallied in all plots in the tract.

To determine baseline (existing) habitat suitability, means of habitat variables for each reach were entered into the HSI models for each evaluation species. To make data handling more efficient, HSI models were programmed in SAS. The SAS versions were checked against those provided by FWS with their HSI software by running sample data sets and comparing output.

Estimating Effects of Hydrologic Change

For the two water-dependent species — wood duck and mink — the impacts of altered hydrology could be evaluated directly from estimates of pre- and post-project flooded acres and flood durations provided by CEMVK. For the remaining evaluation species, however, indirect effects of project-induced changes in hydrology included the potential for long-term changes in forest structure or species composition. Two approaches were used to evaluate those effects: (1) gathering opinions from experts and (2) simulating forest growth in relation to hydrology.

Workshop of Experts

On 2 April 1990, a workshop was convened at the Waterways Experiment Station to consider approaches to predicting future forest conditions in the Yazoo Basin as a result of proposed flood control projects. Workshop participants were Mr. Steve Meadows, US Forest Service Southern Hardwoods

Laboratory, Stoneville, MS; Mr. Adrian Farmer, USGS Biological Resources Division, Fort Collins, CO; Mr. Will Conner, Belle Baruch Institute of Clemson University, Georgetown, SC; Dr. Jean O'Neil, WES; and Dr. Chuck Klimas and Mr. Jim Teaford, formerly of WES.

The consensus of workshop participants was that there were unlikely to be any significant changes in forest cover types or in overstory conditions during the 50-year economic life of the Yazoo Basin projects. Although changes in the understory were possible (i.e., changes in coverage and density of shrubs and herbaceous vegetation), the only anticipated effects on the tree layer were increased growth and productivity resulting from less frequent and shorter duration flooding. The participants further recommended that a bottomland hardwood succession model called FORFLO be used to provide more quantitative predictions of forest changes under altered hydrologic regimes.

FORFLO Simulation

FORFLO (Pearlstine et al. 1985, Pearlstine 1985) was developed by the USGS National Wetlands Research Center. It simulates the growth of individual trees on a 0.2-acre plot as influenced by hydrologic regime and interactions with other species. FORFLO was used to predict forest succession on areas subject to altered hydrology in the Yazoo Basin.

Standard inputs to this stochastic model include the species, diameters, and densities of trees on the plot; biweekly means and standard deviations of flood-water surface elevations throughout the year; ground surface elevation; average growing-season water-table depth; and soil type. Standard outputs include annual flood duration; average flood height; density, basal area, and frequency of tree species on the plot by diameter category (<10 inches and >10 inches DBH); total canopy closure; and canopy closure of mast-bearing trees. Simulated plot data are displayed at 10-year intervals.

Although FORFLO simulates growth of trees on a small plot, the HEP focused on average conditions within forest tracts. Therefore, data from sample plots within a tract were first averaged (by cover type) before they were entered into FORFLO. With-project and without-project hydrologic data were provided by CEMVK for selected test sites within the Steele Bayou Basin, and soil data were taken from the appropriate published county soil survey. Additional FORFLO simulations were performed on hypothetical data that represented the extremes of hydrologic change expected in the basin.

The FORFLO model was modified slightly for this study. Estimates of MEANDBH, DENTR20, and TREEHT were produced in addition to the standard output. For the purpose of estimating MEANDBH, which considers only overstory trees, it was necessary to assume that any tree ∃6 inches DBH was an overstory tree. Modifications to the program and all FORFLO simulations were performed by Mr. James A. Allen, USGS National Wetlands Research Center, Lafayette, LA.

To evaluate indirect effects of altered flooding regime on habitats for barred owls, gray squirrels, Carolina chickadees, and pileated woodpeckers, FORFLO was used to estimate future values of critical variables in their HSI models. Thus, values of MEANDBH, MASTPROP, TREEHT, and DENTR20 were predicted after either 50 years of continued pre-project hydrology (the without-project simulation) or 50 years under an estimated or hypothetical with-project flooding regime.

FORFLO Results

The FORFLO results supported the conclusions of the experts by confirming that the major indirect effect of reduced flooding over the life of a project is slightly increased growth and productivity of trees. Therefore, MEANDBH, TREEHT, and DENTR20 tended to be greater after 50 years with drier conditions. These changes generally benefitted barred owls, Carolina chickadees, and pileated woodpeckers. Similarly, increased flooding would have a slight negative effect on habitat suitability for these species. The effects on mast-producing trees (MASTPROP), and therefore on gray squirrels, were less predictable but, on average, appeared to be neutral.

After reviewing these results, the HEP Team decided that indirect impacts to habitats for barred owls, gray squirrels, Carolina chickadees, and pileated woodpeckers would not be considered further in the impact analysis, although the Team recognized that small benefits and/or impacts may accrue to these species as a result of a project. However, any potential changes in habitat quality would likely be insignificant because most forest tracts in the project area would not experience the levels of hydrologic change that were simulated with FORFLO.

Analysis of Impacts

HEP software, provided by the USGS Biological Resources Division, Fort Collins, CO, was used to estimate impacts of project alternatives on habitat availability for the six evaluation species. Separate analyses were performed for each project reach.

Project Life and Period of Analysis

HEP requires that habitat availability for each species be estimated for each of several target years over a period of analysis that may include the economic life of the project plus any additional pre-project impact period. For the YBP, the 50-year economic life of the project will begin in 2006, when construction of the pumping plant is scheduled to be complete, and end in 2056. Under the levee alternative, construction would actually end in 2007 but, for consistency, the same project lifetime (2006 to 2056) was used for all plans.

It was assumed that all construction impacts associated with the levee alternative would occur in the median year of the period during which the work was done. This approach eliminated the need to predict impacts yearly during construction. Levee construction will begin in 2001 and end in 2007. Therefore, the median work year is 2004 (target year 1 or TY1 in the HEP analysis) and the period of analysis extends from 2004 through 2056. For the pump alternatives, hydrologic changes will occur only after the pump is completed and operating in 2006. Therefore, effects of all pump alternatives will first be felt in TY3. For plans with a reforestation component, it was assumed that tree planting would occur at the same time as other construction activities. Therefore, the assumed median date of reforestation activities was also 2004 (TY1). All habitat impacts and benefits were annualized over the 50-year economic life of the project.

Calculating Average Annual Habitat Units

Overall effects of each project plan in each reach were determined by calculating the net change in AAHUs between with-project and without-project conditions for each evaluation species. Land that was cleared during construction was assumed to remain in a cleared condition throughout the life of the project.

PART III: BASELINE HABITAT CONDITIONS

Habitat Variables and HSI Values

Within reaches, the amount of variability in habitat measurements was generally quite low (Table 5), indicating that tracts were fairly uniform in age and structure. There were also few differences in habitat characteristics across reaches. Tree heights (TREEHT) across reaches averaged 58-66 ft with 72-82% canopy cover (TREECOV). Between 39-47% of canopy cover was of mast-bearing trees (MASTPROP). MEANDBH ranged from 12-17 inches. Densities of large trees (DENTR20) ranged from 7-12 per acre, and were highest in Reach 3.

HSI values were also fairly stable among reaches (Table 6). HSI values ranged from 0.70-0.91 for barred owls, 0.58-0.64 for gray squirrels, 0.63-0.76 for Carolina chickadees, 0.73-0.93 for pileated woodpeckers, 0.41-0.58 for wood ducks, and 0.11-0.12 for mink. Most HSI values ranged from 0.50-0.90, indicating better-than-average habitat quality for the evaluation species. One exception was the very low HSI for mink in forested wetlands, due to average flooding durations that barely exceeded the minimum 25% cumulative duration required for use of an area by mink.

As in previous analyses of Yazoo Basin flood control projects, HSI values for each species reflected the limiting influences of only one or two habitat variables in each model. The HSI value for barred owls tended to be dictated by MEANDBH; the value for gray squirrels was limited by MASTPROP; Carolina chickadee HSI was limited by TREEHT; pileated woodpecker HSI by DENTR20; wood duck HSI by either BROODCOV or WDCAVITY; and mink HSI by PCTYEAR.

PART IV: ANALYSIS OF PROJECT PLANS

Effects of a project plan on habitat availability for each evaluation species were determined by calculating the change in AAHUs between the no-action alternative and each with-project plan. Results were calculated separately for each reach.

As described previously, YBP alternative plans consist of different combinations of structural features, water management options, and reforestation goals (Table 1). The purpose of this analysis was to determine the overall effect of each plan on the availability and quality of wildlife habitats. To perform the HEP analysis, however, it was convenient to split each plan into two components: (1) the combined effects of structural and water management options, and (2) the effects of reforestation, if applicable to a particular plan. The overall effect of a plan was simply the sum of these two components.

Effects of Structural and Water Management Options

The combined effects of structural and water management options (without reforestation) for each project plan in each reach are shown in Tables 7, 8, 9, and 10, which were summarized from the HEP Forms C and D results given in Appendix A. Negative results indicate net loss of AAHUs and positive values indicate net gains.

The non-structural alternatives (Plans 1 and 2) would have no impacts or benefits to any of the six evaluation species, as long as the non-structural (reforestation) component of Plan 2 is not considered.

The levee alternative (Plan 29) involves clearing of woodlands in Reaches 2 and 4, as well as changes in flooding regime in all four reaches. The clearing of woodlands would result in AAHU losses for the four generalist species — barred owls, gray squirrels, Carolina chickadees, and pileated woodpeckers (Tables 8 and 10). For the water-dependent species (wood duck and mink), changes in habitat availability among reaches were similar in direction. Both species would lose habitat in Reaches 1, 2, and 3, and gain habitat in Reach 4. Predicted changes in habitat for both species were mainly due to gains and losses in acreage of forest flooded for at least part of the year.

Tables 7 through 10 give the total AAHU change for each plan across all six evaluation species. Care should be used in interpreting these results. AAHU totals can be misleading when some evaluation species gain habitat while others lose.

Most of the combination structural/non-structural alternatives (i.e., Plans 3 through 26, and 31 through 35) would affect only the mink and wood duck. Mink would be affected mainly by changes in the acreage of forest that would meet its minimum requirement for flooding at least 25% of the year (Table 4). The predicted magnitude of change for mink (both gains and losses) varied considerably by reach and plan (Tables 7, 8, 9, and 10). Under most plans, wood ducks would lose habitat in all four reaches. Only Plans 31, 34, and 35 would result in net gains for wood ducks (not counting the effects of reforestation). Because the site for the pumping station was cleared as part of a previous project, there would be no additional clearing of forest land under these plans as part of the YBP. Therefore, there would be no further impacts to barred owls, gray squirrels, Carolina chickadees, or pileated woodpeckers from any of these alternatives.

Effects of Reforestation

Reforestation of existing cleared lands as a non-structural flood damage reduction feature is an integral part of eighteen project plans (Table 1). In each case, existing open lands below a specified elevation would be targeted for reforestation. Estimates of the acreage of open land potentially subject to reforestation were provided by CEMVK (Table 11). Only a project-wide reforestation total was specified; for this analysis, the total was divided equally among the four reaches. This analysis assumes that all of these lands will be planted to bottomland hardwood tree species concurrently with project construction. HEP was used to estimate the potential AAHU gains that would result from reforestation of all of the applicable acreage.

The estimation of AAHU benefits derived from reforesting existing cleared land requires predictions of habitat quality or HSI for each evaluation species over the first 50 years or more of forest growth. For this purpose, predicted HSI values at specific target years over the life of the project were developed by consensus of the original Steele Bayou / Upper Yazoo Project HEP Team (Wakeley and Marchi 1991; see values in Appendix B) and have been used in each subsequent component of the reformulated Yazoo Basin flood control projects.

In addition to forest growth, benefits to the water-dependent species (wood duck and mink) depend upon the flooding regime on lands targeted for reforestation. For the wood duck, CEMVK Hydraulics staff estimated the average acreage of existing cleared land targeted for reforestation that would flood continuously from March through May (Table 12). Suitability of reforested areas for wood ducks also requires that well-maintained and predator-proof nest boxes be provided in flooded areas. The Fish and Wildlife Service (Robert Barkley, personal communication, 14 May 1992) recommends an initial nest box density of 0.5 boxes/acre in tracts <100 acres, and 0.1 boxes/acre in tracts ∃100 acres. Additional boxes can be added later if warranted by the level of use by nesting wood ducks. For the mink model, CEMVK provided estimates of the number of acres of lands targeted for reforestation that are flooded >25% of the year at 2-year frequency, and estimates of the actual average flooding duration in those areas (Table 13).

Predicted HSI values were used with estimates of reforestation acreage and average flooding regime on reforested lands to calculate potential AAHU gains for each evaluation species, reach, and plan (Tables 14, 15, 16, and 17). These tables were compiled from the HEP Form C results given in Appendix B. All of the proposed reforestation options would result in significant benefits to each evaluation species. Greatest benefits would accrue to the generalist species — barred owl, gray squirrel, Carolina chickadee, and pileated woodpecker — which could utilize all of the reforested acreage, at least after the newly planted forest has reached an appropriate stage of development for each species. Additional benefits would accrue to the water-dependent species — wood duck and mink — which would utilize those portions of the reforested area that met their specific flooding requirements. Obviously, plans that involve greater reforested acreage would have greater overall wildlife benefits than those involving less acreage.

Overall Effects of Project Plans

The overall effect of each project plan on availability of wildlife habitat in the YBP area was determined by summing the effects of structural and water management options (Tables 7, 8, 9, and 10)

with the effects of the non-structural (reforestation) component (Tables 14, 15, 16, and 17). Overall effects of each plan across all four reaches combined are shown in Table 18.

Twelve alternatives (Plans 3, 4, 5, 9, 15, 16, 17, 21, 27, 28, 29, and 30) resulted in overall net losses of wildlife habitat ranging from –876 to – 7,957 AAHU for the six evaluation species combined. Most of these (except Plan 29) were neutral to the four generalist species because they did not involve any changes in forest acreage. Habitat losses associated with these plans were primarily to wood ducks, although eight of the plans would also result in losses of habitat for mink.

All of the other alternatives resulted in overall habitat gains, although some plans would result in habitat tradeoffs of one species for another. In particular, Plans 10, 11, 22, and 23 would reduce AAHU for wood ducks while increasing AAHU for mink.

Plans that include reforestation of existing cleared lands (Plans 2, 6, 7, 8, 12, 13, 14, 18, 19, 20, 24, 25, 26, 31, 32, 33, 34, and 35) would increase habitat availability for all six evaluation species. Total AAHU benefits of plans involving reforestation ranged from nearly 73,000 AAHU for Plan 18 to over 181,000 AAHU for Plan 34 (Table 18). In general, overall habitat benefits were roughly proportional to the acreage of existing cleared land targeted for reforestation under each plan (Table 11). The very large predicted benefits of Plan 34 were due to the combination of a large reforestation component (107,000 acres) and a water-management plan that would produce unusually large benefits for wood ducks.

PART V: GENERIC MANAGEMENT PLANS

YBP alternative plans considered in the preceding analysis incorporated specific water management and non-structural (reforestation) features that benefit wildlife species while, at the same time, satisfying flood control objectives. The purpose of this section is to provide some generic plans that could be used to compensate for unavoidable habitat losses by reestablishing forest on existing cleared land. Forest reestablishment can be accomplished either by (1) promoting natural revegetation and succession or (2) planting selected tree species (reforestation). This section considers both options, and provides potential benefits to evaluation species on a per-unit-area basis. Results can be used to estimate the acreage required to compensate for a particular impact.

The habitat benefits of establishing new forest vary with the characteristics of the site and may depend upon other features that must be provided at the same time. For example, the four generalist species — barred owl, gray squirrel, Carolina chickadee, and pileated woodpecker — will benefit from almost any newly established forest, if tracts are of sufficient size (>10 acres not counting narrow or fringe woods) and enough time is allowed for growth. Wood ducks, however, require surface water within the forest at least during the brood-rearing period, and have the additional requirement of secure nesting cavities. Mink will use forested wetlands that are flooded >25% of the year, and also will benefit from establishment of forest cover adjacent to streams or lakes, as long as shoreline vegetation is allowed to develop (Allen 1986).

Example Management Plans

The HEP software was used to calculate AAHUs that could be gained by reestablishing bottomland hardwood forest on 100 acres of existing cleared land under various management plans (Table 19). Models of the predicted HSI values for each evaluation species over the initial stages of forest growth were developed by consensus of the Steele Bayou/Upper Yazoo Project HEP Team (Wakeley and Marchi 1991). It was assumed that management plans would be implemented concurrently with construction of the YBP. Thus the median date of forest establishment was assumed to be 2004 (TY 1) and the analysis extended to the end of the YBP project life in 2056 (TY 53). AAHU benefits were annualized over the 50-year economic life of the project.

In practice, the species composition of reestablished woods will depend on the existing hydrology and soil characteristics of the site. Although Table 19 was developed specifically for BLH, it is anticipated that actual forest replacement will involve a mix of species, including cypress.

Management Plans (MP) 1, 2, and 3 assume that the area is allowed to revegetate naturally with a mix of typical bottomland species, whereas MP 4, 5, and 6 involve active reforestation by planting primarily mast-bearing species (i.e., oaks and hickories). Within each category, plans differ according to the assumed flooding regime within the developing forest, or its proximity to a semipermanent stream or lake. Complete HEP Form C results are given in Appendix B.

MP 1 and MP 4 (Table 19) assume that the site is flooded cumulatively less than 25% of the year (<90 days) and is not located within 328 ft of a stream or lake containing surface water more than 90 days each year. Therefore, reestablishing forest cover on the site will benefit barred owls, gray squirrels, Carolina chickadees, and pileated woodpeckers, but will provide no habitat for either mink or breeding

wood ducks. It probably would not be appropriate to rely solely on these management plans for any project that involves significant impacts to the water-dependent species. However, these MPs may be appropriate in some portions of a larger management area or if more than one site is used in mitigation of project impacts.

The remaining plans are applicable to management areas adjacent to streams or lakes that contain water for long periods each year. As long as dense shoreline cover is encouraged, these areas will provide added benefits to mink and wood ducks. The plans are not well suited to floodplain situations because the frequent, very long-duration flooding would likely reduce habitat value for the generalist forest species (barred owl, gray squirrel, Carolina chickadee, pileated woodpecker) and may prevent the establishment of a diverse and structurally complex forest.

MP 2 (natural succession) and MP 5 (reforestation) assume that the management area is within 328 ft of a stream or lake that contains surface water for exactly 6 months cumulatively each year including continuous inundation during the March-May wood duck brood-rearing period. If the adjacent water body contained water less than 6 months, the site would have somewhat less value to mink, whereas it would have greater value if water was present more than 6 months. The benefit to wood ducks depends upon the presence of abundant over-water brood cover, and adequate numbers of well-maintained, predator-proof nesting boxes.

The appropriate number of nest boxes should be determined empirically by erecting a number of boxes, monitoring their success, and adding more boxes as needed. As mentioned previously, the Fish and Wildlife Service (Robert Barkley, personal communication, 14 May 1992) recommends an initial nesting box density of 0.5 boxes/acre in tracts <100 acres, and 0.1 boxes/acre in tracts ∃100 acres. Regenerating forest areas lacking nest boxes would provide no AAHU for wood ducks unless a mature stand containing many natural cavities is immediately adjacent to the newly established forest.

MP 3 and MP 6 assume that the reforested area is within 328 ft of a stream or lake, that water is present more than 9 months each year including the March-to-May period, and that wood duck boxes are provided. Well-developed shoreline cover (for mink) and brood cover over the water (for wood ducks) are required.

Table 19 can be used to estimate compensation requirements for a specified level of impact, by selecting a MP that is appropriate for the site. For example, the overall impact of YBP Plan 29 was !7,849 AAHU (Table 18). Complete compensation for these losses would require 5,429 acres ([7,848.67 / 144.58] H 100) of reforestation under MP 4, assuming unlimited trade-offs of AAHU among species.

REFERENCES

Allen, A. W. 1986. "Habitat Suitability Index Models: Mink (Revised)," Biological Report 82(10.127), US Fish and Wildlife Service, Washington, DC.

Allen, A. W. 1987a. "Habitat Suitability Index Models: Barred Owl," Biological Report 82(10.143), US Fish and Wildlife Service, Washington, DC.

Allen, A. W. 1987b. "Habitat Suitability Index Models: Gray Squirrel (Revised)," Biological Report 82(10.135), US Fish and Wildlife Service, Washington, DC.

Pearlstine, L. 1985. "FORFLO -- A Bottomland Forest Floodplain Model: User's Manual and Programming Notes," NCET Open File No. 85-3, US Fish and Wildlife Service, Slidell, LA.

Pearlstine, L., McKellar, H., and Kitchens, W. 1985. "Modelling the Impacts of a River Diversion on Bottomland Forest Communities in the Santee River Floodplain, South Carolina," Ecological Modelling, Vol 29, pp 283-302.

Roberts, T. H., and O'Neil, L. J. 1985. "Species Selection for Habitat Assessments," Miscellaneous Paper EL-85-8, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

SAS Institute, Inc. 1985. "SAS Language Guide for Personal Computers, Version 6 Edition," Cary, NC.

Schroeder, R. L. 1983a. "Habitat Suitability Index Models: Pileated Woodpecker," FWS/OBS-82/10.39, US Fish and Wildlife Service, Washington, DC.

Schroeder, R. L. 1983b. "Habitat Suitability Index Models: Black-Capped Chickadee," FWS/OBS-82/10.37, US Fish and Wildlife Service, Washington, DC.

Sousa, P. J., and Farmer, A. H. 1983. "Habitat Suitability Index Models: Wood Duck," FWS/OBS-82/10.43, US Fish and Wildlife Service, Washington, DC.

US Fish and Wildlife Service. 1980a. "Habitat as a Basis for Environmental Assessment," 101 ESM, US Fish and Wildlife Service, Washington, DC.

US Fish and Wildlife Service. 1980b. "Habitat Evaluation Procedures (HEP)," 102 ESM, US Fish and Wildlife Service, Washington, DC.

Wakeley, J. S. 1991. "An Evaluation of Impacts to Terrestrial Habitats Resulting from Maintenance and Operation of Reservoir Outlet Channels in Northern Mississippi," final report to the US Army Engineer District, Vicksburg, MS.

Wakeley, J. S. 1995. "An Evaluation of Impacts to Terrestrial Habitats Resulting from the Big Sunflower Maintenance Project, Mississippi," final report to the US Army Engineer District, Vicksburg, MS.

Wakeley, J. S. 1996. "An Evaluation of Impacts to Terrestrial Habitats Resulting from Maintenance and Construction Alternatives, Mississippi Delta Project, Mississippi," final report to the US Army Engineer District, Vicksburg, MS.

Wakeley, J. S., and Marchi, R. A. 1991. "An Evaluation of Impacts to Terrestrial Habitats Resulting from Flood Control Projects in the Steele Bayou Basin Mississippi," Appendix 12 in Volume III of Upper Steele Bayou Basin Reformulation Study, US Army Engineer District, Vicksburg, MS.

Wakeley, J. S., and Marchi, R. A. 1992. "An Evaluation of Impacts to Terrestrial Habitats Resulting from Flood Control Projects in the Upper Yazoo River Basin, Mississippi," final report to the US Army Engineer District, Vicksburg, MS.

Wakeley, J. S., and O'Neil, L. J. 1988. "Techniques to Increase Efficiency and Reduce Effort in Applications of the Habitat Evaluation Procedures (HEP)," Technical Report EL-88-13, US Army Engineer Waterways Experiment Station, Vicksburg, MS.

Table 1

Alternative Project Plans, Yazoo Backwater Project

Plan	Features			
	Structural	Easement		
		Existing Woodlands	Existing Open Lands	Water Management
1	N/A	Preserve below 100.3 ft NGVD	Use retained	N/A
2	N/A	Preserve below 100.3 ft NGVD	Reforest below 90 ft NGVD	N/A
3	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	N/A
4	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	Below 80 ft NGVD[b]
5	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	Below 85 ft NGVD[c]
6	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	70-73 ft NGVD[d]
7	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	Below 80 ft NGVD[b]
8	14,000-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	Below 85 ft NGVD[c]
9	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	N/A
10	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	Below 80 ft NGVD[b]
11	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	Below 85 ft NGVD[c]
12	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	N/A
13	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	Below 80 ft NGVD[b]
14	14,000-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	Below 85 ft NGVD[c]
15	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	N/A
16	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	Below 80 ft NGVD[b]

Continued.

Table 1. Continued.

Plan	Features			
	Structural	Easement		
		Existing Woodlands	Existing Open Lands	Water Management
17	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Use retained below 85 ft NGVD	Below 85 ft NGVD[c]
18	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	N/A
19	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	Below 80 ft NGVD[b]
20	17,500-cfs pump[a]	Preserve below 85 ft NGVD	Reforest below 85 ft NGVD	Below 85 ft NGVD[c]
21	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	N/A
22	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	Below 80 ft NGVD[b]
23	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Use retained below 90 ft NGVD	Below 85 ft NGVD[c]
24	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	N/A
25	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	Below 80 ft NGVD[b]
26	17,500-cfs pump[a]	Preserve below 90 ft NGVD	Reforest below 90 ft NGVD	Below 85 ft NGVD[c]
27	14,000-cfs pump[e]	N/A	N/A	70-73 ft NGVD[d]
28	17,500-cfs pump[e]	N/A	N/A	N/A
29	Levee	N/A	N/A	N/A
30	14,000-cfs pump	Preserve below 100.3 ft NGVD	N/A	N/A
31	14,000-cfs pump	N/A	Reforest below 87 ft NGVD and south of Highway 14	Below 75 ft NGVD[f]
32	14,000-cfs pump	N/A	Reforest below 87 ft NGVD	70-73 ft NGVD[d]
33	14,000-cfs pump	N/A	Reforest below 91 ft NGVD	70-73 ft NGVD[d]

Continued.

Table 1. Concluded.

Plan	Features			
	Structural	Easement		
		Existing Woodlands	Existing Open Lands	Water Management
34	14,000-cfs pump	N/A	Reforest below 91 ft NGVD	70-73 ft NGVD, reintroduce up to 87 ft NGVD[g]
35	14,000-cfs pump	N/A	Reforest below 88.5 ft NGVD	70-73 ft NGVD, reintroduce up to 87 ft NGVD[g]

[a] Pump would be operated to provide flood damage reduction for cleared lands above the easement elevation.
[b] 1 December to 1 March.
[c] 80 ft, 1 December to 1 January and 15 February to 1 March; 85 ft, 1 January to 15 February.
[d] Operation of the drainage structure at Steele Bayou would be modified to maintain a 70 to 73-ft elevation at Steele Bayou during low-water periods.
[e] Pump would be operated to provide flood damage reduction for cleared lands above elevation 80 ft NGVD, except during 1 December to 1 March when pump would be operated at 85 ft NGVD.
[f] Year round.
[g] Operation of the drainage structure at Steele Bayou would be modified to maintain a 70 to 73-ft elevation at Steele Bayou during low-water periods and to reintroduce Mississippi River flows up to 87 ft NGVD.

Table 2

Names and Abbreviations of Habitat Variables
Used in the HSI Models

Variable	Definition	Evaluation Species*
AVGSN15	Mean DBH of snags >15 inches DBH	PW
BROODCOV	Percent of water surface covered by potential wood duck brood cover	WD
CAVITY	Number of living trees with cavities >1 inch in diameter per acre	CC
DENSN4	Density of snags >4 inches DBH per acre	CC
DENSN15	Density of snags >15 inches DBH per acre	PW
DENTR20	Density of trees >20 inches DBH per acre	PW
EMERGCOV	Percent cover of emergent herbaceous vegetation	MK
MASTPROP	Proportion of total tree canopy cover that is hard-mast producers >10 inches DBH	GS
MASTSPEC	Number of hard mast species >10 inches DBH on the plot (or in the tract)	GS
MEANDBH	Mean DBH of overstory trees	GS, BO
OVERCOV	Percent canopy cover of overstory trees	BO
PCTYEAR	Percent of year with surface water present	MK
SHORECOV	Percent shoreline cover	MK
SHRUBCOV	Percent cover of shrubs	MK
SHTRCOV	Percent cover of trees and shrubs combined within 328 ft of the water's edge	MK
STUMPLOG	Combined number of stumps and logs per acre	PW
TREECOV	Percent canopy cover of trees	MK, PW, GS, CC
TREEHT	Average height of all trees	CC
TRSN20	Density of trees and snags >20 inches DBH per acre	BO
WDCAVITY	Number of cavities ∃3H4 inches per acre	WD
WDBOXES	Number of maintained and predator-proof nest boxes for wood ducks per acre	WD

*Barred owl (BO), Carolina chickadee (CC), gray squirrel (GS), mink (MK), pileated woodpecker (PW), and wood duck (WD).

Table 3

Estimated Acres of Wood Duck Habitat
Under Each Project Plan, Yazoo Backwater Project

Project Plan Or Existing Condition	Average Number of Acres of Forest Flooded Continuously from March through May			
	Reach 1	Reach 2	Reach 3	Reach 4
Existing Condition	27,508	3,653	20,676	8,804
Plans 1 and 2	27,508	3,653	20,676	8,804
Plans 3, 4, 5, 6, 7, and 8	25,022	3,201	17,856	7,607
Plans 9, 10, 11, 12, 13, and 14	26,874	3,531	20,167	8,353
Plans 15, 16, 17, 18, 19, and 20	24,344	3,073	16,992	7,331
Plans 21, 22, 23, 24, 25, and 26	26,626	3,437	19,507	8,140
Plans 27 and 30	23,363	2,911	15,730	7,147
Plan 28	22,240	2,751	14,787	6,599
Plan 29	24,344	2,571	14,975	10,359
Plan 31	28,609	3,673	21,158	8,672
Plan 32	25,598	3,261	18,104	7,927
Plan 33	27,122	3,579	20,498	8,459
Plan 34	32,635	3,943	22,430	9,201
Plan 35	29,030	3,854	21,609	9,201

Source of data: CEMVK Hydraulics Staff.

Table 4

Estimated Acres of Forested Wetland Habitat
Suitable for Mink Under Each Project Plan, Yazoo Backwater Project

Project Plan or Existing Condition	Acres of Forest Flooded ∃90 Days (25% Duration) at 2-Year Frequency			
	Reach 1	Reach 2	Reach 3	Reach 4
Existing Condition	25,474 (30.4%)*	3,440 (31.2%)	19,540 (30.9%)	8,150 (30.8%)
Plans 1, 2	25,474 (30.4%)	3,440 (31.2%)	19,540 (30.9%)	8,150 (30.8%)
Plans 3, 6	24,344 (30.4%)	3,201 (31.2%)	17,856 (30.9%)	7,607 (30.8%)
Plans 4, 7	29,133 (31.1%)	3,673 (32.0%)	21,158 (31.6%)	8,672 (31.5%)
Plans 5, 8	32,400 (31.1%)	4,439 (31.9%)	24,769 (31.6%)	10,116 (31.5%)
Plans 9, 12	24,796 (30.4%)	3,295 (31.2%)	18,516 (30.9%)	7,820 (30.8%)
Plans 10, 13	29,410 (31.1%)	3,741 (31.9%)	21,476 (31.6%)	8,804 (31.5%)
Plans 11, 14	33,902 (31.1%)	4,709 (31.9%)	26,058 (31.6%)	10,481 (31.5%)
Plans 15, 18	24,344 (30.4%)	3,201 (31.2%)	17,856 (30.9%)	7,607 (30.8%)
Plans 16, 19	29,133 (31.1%)	3,673 (32.0%)	21,158 (31.7%)	8,672 (31.5%)
Plans 17, 20	32,400 (31.1%)	4,439 (31.9%)	24,769 (31.6%)	10,116 (31.5%)
Plans 21, 24	24,796 (30.4%)	3,295 (31.2%)	18,516 (30.9%)	7,820 (30.9%)
Plans 22, 25	29,410 (31.1%)	3,741 (31.9%)	21,476 (31.6%)	8,804 (31.5%)
Plans 23, 26	33,902 (31.1%)	4,709 (31.9%)	26,058 (31.6%)	10,481 (31.5%)
Plans 27, 30	23,414 (30.4%)	2,901 (31.2%)	15,839 (30.9%)	6,962 (30.8%)

Continued.

Table 4. Concluded.

Project Plan or Existing Condition	Acres of Forest Flooded ∃90 Days (25% Duration) at 2-Year Frequency			
	Reach 1	Reach 2	Reach 3	Reach 4
Plan 28	23,414 (30.4%)	2,901 (31.2%)	15,839 (30.9%)	6,962 (30.8%)
Plan 29	20,767 (30.3%)	1,230 (31.1%)	12,920 (30.8%)	11,388 (30.7%)
Plan 31	25,022 (30.1%)	3,343 (30.3%)	18,847 (30.2%)	7,927 (30.3%)
Plan 32	25,180 (30.4%)	3,381 (31.2%)	19,111 (30.9%)	8,012 (30.8%)
Plan 33	25,361 (30.4%)	3,423 (31.2%)	19,408 (30.9%)	8,108 (30.8%)
Plan 34	26,062 (30.2%)	3,598 (30.5%)	20,630 (30.5%)	8,502 (30.5%)
Plan 35	25,949 (30.2%)	3,569 (30.5%)	20,432 (30.5%)	8,438 (30.4%)

*Estimated actual average cumulative flooding duration.
Source of data: CEMVK Hydraulics Staff.

Table 5

Means and Standard Errors of Habitat Variables,
Yazoo Backwater Project

	Reach 1		Reach 2		Reach 3		Reach 4	
Variable	Mean	SE*	Mean	SE	Mean	SE	Mean	SE
TREEHT	58.77	2.70	66.40	2.55	64.76	2.23	57.76	3.67
TREECOV	82.36	2.68	75.13	4.33	77.63	2.38	71.95	2.65
OVERCOV	71.01	3.14	61.57	4.45	61.13	2.95	59.88	3.08
SHRUBCOV	38.23	3.77	34.43	3.22	30.47	3.45	39.83	4.77
SHTRCOV	89.47	2.29	86.30	2.07	84.77	1.57	87.49	2.02
EMERGCOV	9.50	3.65	2.00	0.98	2.33	0.82	1.30	0.83
BROODCOV	28.98	4.05	23.65	2.96	25.42	6.32	39.53	3.99
MASTPROP	0.41	0.07	0.39	0.06	0.47	0.09	0.42	0.06
STUMPLOG	37.14	7.94	25.00	5.19	18.16	2.94	15.63	3.41
CAVITY	16.69	3.00	14.00	3.30	11.35	1.92	7.83	1.93
WDCAVITY	5.26	0.92	6.50	1.98	2.85	0.40	3.29	0.94
WDBOXES	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MEANDBH	12.45	0.71	14.09	1.31	17.32	1.50	13.59	1.09
DENTR20	7.92	1.95	9.67	2.41	12.15	3.06	7.33	2.47
DENSN4	8.20	1.11	6.00	1.41	4.97	0.81	7.08	1.64
AVGSN15	23.97	2.58	22.50	4.50	20.40	1.57	22.21	1.77
DENSN15	1.07	0.41	0.33	0.22	0.76	0.28	1.50	0.39
TRSN20	8.49	1.91	9.83	2.51	12.43	3.02	8.17	2.47
MASTSPEC	2.94	0.42	2.70	0.37	2.50	0.31	3.10	0.28

* Standard errors reflect variability among tracts.

Table 6

Calculated Baseline Habitat Suitability Index (HSI) Values
for Forested Habitats, Yazoo Backwater Project

Project Reach	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink**
Reach 1	0.70	0.58	0.65	0.79	0.58	0.11
Reach 2	0.78	0.60	0.76	0.89	0.47	0.12
Reach 3	0.91	0.64	0.74	0.93	0.41	0.12
Reach 4	0.75	0.62	0.63	0.73	0.47	0.11

* Wood duck HSI applies only to areas flooded from March through May each year (brood habitat).
** Mink HSI applies only to forests flooded >25% of the year at 2-year frequency.

Table 7

Combined Effects of Structural and Water Management Options
(Not Including Non-Structural Reforestation) on Terrestrial Wildlife Habitats
in Reach 1, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 3	0.00	0.00	0.00	0.00	-1456.30	-125.54	-1581.84
Plan 4	0.00	0.00	0.00	0.00	-1456.30	700.64	-755.66
Plan 5	0.00	0.00	0.00	0.00	-1456.30	1096.49	-359.81
Plan 6	0.00	0.00	0.00	0.00	-1456.30	-125.54	-1581.84
Plan 7	0.00	0.00	0.00	0.00	-1456.30	700.64	-755.66
Plan 8	0.00	0.00	0.00	0.00	-1456.30	1096.49	-359.81
Plan 9	0.00	0.00	0.00	0.00	-371.40	-75.33	-446.73
Plan 10	0.00	0.00	0.00	0.00	-371.40	734.20	362.80
Plan 11	0.00	0.00	0.00	0.00	-371.40	1278.48	907.08
Plan 12	0.00	0.00	0.00	0.00	-371.40	-75.33	-446.73
Plan 13	0.00	0.00	0.00	0.00	-371.40	734.20	362.80
Plan 14	0.00	0.00	0.00	0.00	-371.40	1278.48	907.08
Plan 15	0.00	0.00	0.00	0.00	-1853.47	-125.54	-1979.01
Plan 16	0.00	0.00	0.00	0.00	-1853.47	700.64	-1152.83
Plan 17	0.00	0.00	0.00	0.00	-1853.47	1096.49	-756.98
Plan 18	0.00	0.00	0.00	0.00	-1853.47	-125.54	-1979.01
Plan 19	0.00	0.00	0.00	0.00	-1853.47	700.64	-1152.83
Plan 20	0.00	0.00	0.00	0.00	-1853.47	1096.49	-756.98
Plan 21	0.00	0.00	0.00	0.00	-516.68	-75.33	-592.01
Plan 22	0.00	0.00	0.00	0.00	-516.68	734.20	217.52
Plan 23	0.00	0.00	0.00	0.00	-516.68	1278.48	761.80
Plan 24	0.00	0.00	0.00	0.00	-516.68	-75.33	-592.01
Plan 25	0.00	0.00	0.00	0.00	-516.68	734.20	217.52
Plan 26	0.00	0.00	0.00	0.00	-516.68	1278.48	761.80
Plan 27	0.00	0.00	0.00	0.00	-2428.14	-228.87	-2657.01
Plan 28	0.00	0.00	0.00	0.00	-3085.99	-228.87	-3314.86
Plan 29	0.00	0.00	0.00	0.00	-1926.88	-543.66	-2470.54
Plan 30	0.00	0.00	0.00	0.00	-2428.14	-228.87	-2657.01
Plan 31	0.00	0.00	0.00	0.00	644.97	-302.95	342.02
Plan 32	0.00	0.00	0.00	0.00	-1118.88	-32.66	-1151.54
Plan 33	0.00	0.00	0.00	0.00	-226.12	-12.55	-238.67
Plan 34	0.00	0.00	0.00	0.00	3003.40	-197.88	2805.52
Plan 35	0.00	0.00	0.00	0.00	891.59	-209.30	682.29

Table 8

Combined Effects of Structural and Water Management Options
(Not Including Non-Structural Reforestation) on Terrestrial Wildlife Habitats
in Reach 2, Yazoo Backwater Project

	Net Change in Average Annual Habitat Units (AAHU)						
Project Plan	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 3	0.00	0.00	0.00	0.00	-214.56	-28.97	-243.53
Plan 4	0.00	0.00	0.00	0.00	-214.56	102.42	-112.14
Plan 5	0.00	0.00	0.00	0.00	-214.56	210.68	-3.88
Plan 6	0.00	0.00	0.00	0.00	-214.56	-28.97	-243.53
Plan 7	0.00	0.00	0.00	0.00	-214.56	102.42	-112.14
Plan 8	0.00	0.00	0.00	0.00	-214.56	210.68	-3.88
Plan 9	0.00	0.00	0.00	0.00	-57.91	-17.57	-75.48
Plan 10	0.00	0.00	0.00	0.00	-57.91	112.03	54.12
Plan 11	0.00	0.00	0.00	0.00	-57.91	248.84	190.93
Plan 12	0.00	0.00	0.00	0.00	-57.91	-17.57	-75.48
Plan 13	0.00	0.00	0.00	0.00	-57.91	112.03	54.12
Plan 14	0.00	0.00	0.00	0.00	-57.91	248.84	190.93
Plan 15	0.00	0.00	0.00	0.00	-275.33	-28.97	-304.30
Plan 16	0.00	0.00	0.00	0.00	-275.33	102.42	-172.91
Plan 17	0.00	0.00	0.00	0.00	-275.33	210.68	-64.65
Plan 18	0.00	0.00	0.00	0.00	-275.33	-28.97	-304.30
Plan 19	0.00	0.00	0.00	0.00	-275.33	102.42	-172.91
Plan 20	0.00	0.00	0.00	0.00	-275.33	210.68	-64.65
Plan 21	0.00	0.00	0.00	0.00	-102.54	-17.57	-120.11
Plan 22	0.00	0.00	0.00	0.00	-102.54	112.03	9.49
Plan 23	0.00	0.00	0.00	0.00	-102.54	248.84	146.30
Plan 24	0.00	0.00	0.00	0.00	-102.54	-17.57	-120.11
Plan 25	0.00	0.00	0.00	0.00	-102.54	112.03	9.49
Plan 26	0.00	0.00	0.00	0.00	-102.54	248.84	146.30
Plan 27	0.00	0.00	0.00	0.00	-352.23	-65.33	-417.56
Plan 28	0.00	0.00	0.00	0.00	-428.18	-65.33	-493.51
Plan 29	-327.60	-252.00	-319.20	-373.80	-533.97	-278.46	-2085.03
Plan 30	0.00	0.00	0.00	0.00	-352.23	-65.33	-417.56
Plan 31	0.00	0.00	0.00	0.00	9.49	-45.52	-36.03
Plan 32	0.00	0.00	0.00	0.00	-186.08	-7.15	-193.23
Plan 33	0.00	0.00	0.00	0.00	-35.13	-2.06	-37.19
Plan 34	0.00	0.00	0.00	0.00	137.66	-17.18	120.48
Plan 35	0.00	0.00	0.00	0.00	95.41	-20.41	75.00

Table 9

Combined Effects of Structural and Water Management Options
(Not Including Non-Structural Reforestation) on Terrestrial Wildlife Habitats
in Reach 3, Yazoo Backwater Project

	Net Change in Average Annual Habitat Units (AAHU)						
Project Plan	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 3	0.00	0.00	0.00	0.00	-1167.76	-204.10	-1371.86
Plan 4	0.00	0.00	0.00	0.00	-1167.76	409.74	-758.02
Plan 5	0.00	0.00	0.00	0.00	-1167.76	883.75	-284.01
Plan 6	0.00	0.00	0.00	0.00	-1167.76	-204.10	-1371.86
Plan 7	0.00	0.00	0.00	0.00	-1167.76	409.74	-758.02
Plan 8	0.00	0.00	0.00	0.00	-1167.76	883.75	-284.01
Plan 9	0.00	0.00	0.00	0.00	-210.78	-124.11	-334.89
Plan 10	0.00	0.00	0.00	0.00	-210.78	451.49	240.71
Plan 11	0.00	0.00	0.00	0.00	-210.78	1052.95	842.17
Plan 12	0.00	0.00	0.00	0.00	-210.78	-124.11	-334.89
Plan 13	0.00	0.00	0.00	0.00	-210.78	451.49	240.71
Plan 14	0.00	0.00	0.00	0.00	-210.78	1052.95	842.17
Plan 15	0.00	0.00	0.00	0.00	-1525.54	-204.10	-1729.64
Plan 16	0.00	0.00	0.00	0.00	-1525.54	409.74	-1115.80
Plan 17	0.00	0.00	0.00	0.00	-1525.54	883.75	-641.79
Plan 18	0.00	0.00	0.00	0.00	-1525.54	-204.10	-1729.64
Plan 19	0.00	0.00	0.00	0.00	-1525.54	409.74	-1115.80
Plan 20	0.00	0.00	0.00	0.00	-1525.54	883.75	-641.79
Plan 21	0.00	0.00	0.00	0.00	-484.08	-124.11	-608.19
Plan 22	0.00	0.00	0.00	0.00	-484.08	451.49	-32.59
Plan 23	0.00	0.00	0.00	0.00	-484.08	1052.95	568.87
Plan 24	0.00	0.00	0.00	0.00	-484.08	-124.11	-608.19
Plan 25	0.00	0.00	0.00	0.00	-484.08	451.49	-32.59
Plan 26	0.00	0.00	0.00	0.00	-484.08	1052.95	568.87
Plan 27	0.00	0.00	0.00	0.00	-2048.14	-448.56	-2496.70
Plan 28	0.00	0.00	0.00	0.00	-2438.63	-448.56	-2887.19
Plan 29	0.00	0.00	0.00	0.00	-2454.28	-834.12	-3288.40
Plan 30	0.00	0.00	0.00	0.00	-2048.14	-448.56	-2496.70
Plan 31	0.00	0.00	0.00	0.00	199.60	-464.75	-265.15
Plan 32	0.00	0.00	0.00	0.00	-1065.07	-51.99	-1117.06
Plan 33	0.00	0.00	0.00	0.00	-73.71	-16.00	-89.71
Plan 34	0.00	0.00	0.00	0.00	726.33	-76.22	650.11
Plan 35	0.00	0.00	0.00	0.00	386.36	-98.22	288.14

Table 10

Combined Effects of Structural and Water Management Options
(Not Including Non-Structural Reforestation) on Terrestrial Wildlife Habitats
in Reach 4, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 3	0.00	0.00	0.00	0.00	-568.22	-65.81	-634.03
Plan 4	0.00	0.00	0.00	0.00	-568.22	150.84	-417.38
Plan 5	0.00	0.00	0.00	0.00	-568.22	340.39	-227.83
Plan 6	0.00	0.00	0.00	0.00	-568.22	-65.81	-634.03
Plan 7	0.00	0.00	0.00	0.00	-568.22	150.84	-417.38
Plan 8	0.00	0.00	0.00	0.00	-568.22	340.39	-227.83
Plan 9	0.00	0.00	0.00	0.00	-214.09	-40.00	-254.09
Plan 10	0.00	0.00	0.00	0.00	-214.09	168.16	-45.93
Plan 11	0.00	0.00	0.00	0.00	-214.09	388.30	174.21
Plan 12	0.00	0.00	0.00	0.00	-214.09	-40.00	-254.09
Plan 13	0.00	0.00	0.00	0.00	-214.09	168.16	-45.93
Plan 14	0.00	0.00	0.00	0.00	-214.09	388.30	174.21
Plan 15	0.00	0.00	0.00	0.00	-699.23	-65.81	-765.04
Plan 16	0.00	0.00	0.00	0.00	-699.23	150.84	-548.39
Plan 17	0.00	0.00	0.00	0.00	-699.23	340.39	-358.84
Plan 18	0.00	0.00	0.00	0.00	-699.23	-65.81	-765.04
Plan 19	0.00	0.00	0.00	0.00	-699.23	150.84	-548.39
Plan 20	0.00	0.00	0.00	0.00	-699.23	340.39	-358.84
Plan 21	0.00	0.00	0.00	0.00	-315.20	-40.00	-355.20
Plan 22	0.00	0.00	0.00	0.00	-315.20	168.16	-147.04
Plan 23	0.00	0.00	0.00	0.00	-315.20	388.30	73.10
Plan 24	0.00	0.00	0.00	0.00	-315.20	-40.00	-355.20
Plan 25	0.00	0.00	0.00	0.00	-315.20	168.16	-147.04
Plan 26	0.00	0.00	0.00	0.00	-315.20	388.30	73.10
Plan 27	0.00	0.00	0.00	0.00	-786.58	-214.34	-1000.92
Plan 28	0.00	0.00	0.00	0.00	-1046.71	-214.34	-1261.05
Plan 29	-291.38	-240.87	-244.75	-283.61	767.39	288.52	-4.70
Plan 30	0.00	0.00	0.00	0.00	-786.58	-214.34	-1000.92
Plan 31	0.00	0.00	0.00	0.00	-62.66	-107.10	-169.76
Plan 32	0.00	0.00	0.00	0.00	-416.31	-16.73	-433.04
Plan 33	0.00	0.00	0.00	0.00	-163.77	-5.09	-168.86
Plan 34	0.00	0.00	0.00	0.00	188.46	-43.20	145.26
Plan 35	0.00	0.00	0.00	0.00	188.46	-50.31	138.15

Table 11

Acres of Existing Cleared Land Targeted for Non-Structural Flood Damage Reduction (Reforestation) under Different Project Plans, Yazoo Backwater Project*

Plan	Reach 1	Reach 2	Reach 3	Reach 4	Total
Plan 1	0	0	0	0	0
Plan 2	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 3	0	0	0	0	0
Plan 4	0	0	0	0	0
Plan 5	0	0	0	0	0
Plan 6	10,150	10,150	10,150	10,150	40,600
Plan 7	10,150	10,150	10,150	10,150	40,600
Plan 8	10,150	10,150	10,150	10,150	40,600
Plan 9	0	0	0	0	0
Plan 10	0	0	0	0	0
Plan 11	0	0	0	0	0
Plan 12	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 13	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 14	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 15	0	0	0	0	0
Plan 16	0	0	0	0	0
Plan 17	0	0	0	0	0
Plan 18	10,150	10,150	10,150	10,150	40,600
Plan 19	10,150	10,150	10,150	10,150	40,600
Plan 20	10,150	10,150	10,150	10,150	40,600
Plan 21	0	0	0	0	0
Plan 22	0	0	0	0	0
Plan 23	0	0	0	0	0
Plan 24	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 25	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 26	25,387.5	25,387.5	25,387.5	25,387.5	101,550
Plan 27	0	0	0	0	0
Plan 28	0	0	0	0	0
Plan 29	0	0	0	0	0
Plan 30	0	0	0	0	0
Plan 31	10,025	10,025	10,025	10,025	40,100
Plan 32	15,625	15,625	15,625	15,625	62,500
Plan 33	26,750	26,750	26,750	26,750	107,000
Plan 34	26,750	26,750	26,750	26,750	107,000
Plan 35	19,325	19,325	19,325	19,325	77,300

* For all plans, only a total potential acreage of reforestation was known. For analysis, the total was arbitrarily divided equally among reaches.

Table 12

Acres of Existing Cleared Land Targeted for Non-Structural Flood Damage Reduction (Reforestation) That Are Potential Wood Duck Habitat, Yazoo Backwater Project

Project Plan with Reforestation Component	Average Number of Acres of Existing Cleared Land Flooded Continuously from March through May			
	Reach 1	Reach 2	Reach 3	Reach 4
Plan 2	13,681	6,870	2,721	10,539
Plans 6, 7, and 8	10,045	5,671	2,284	9,289
Plans 12, 13, and 14	10,859	6,303	2,562	10,084
Plans 18, 19, and 20	9,782	5,347	2,165	9,001
Plans 24, 25, and 26	10,755	6,122	2,482	9,857
Plan 31	11,583	6,667	2,681	10,424
Plan 32	10,461	5,970	2,403	9,630
Plan 33	10,962	6,398	2,602	10,197
Plan 34	11,907	7,478	2,840	10,884
Plan 35	11,583	6,870	2,721	10,539

Source of data: CEMVK Hydraulics Staff.

Table 13

Acres of Existing Cleared Land Targeted for Non-Structural Flood Damage Reduction (Reforestation) That Are Potential Mink Habitat, Yazoo Backwater Project

Project Plan	Acres of Land Flooded ∃90 Days (25% Duration) at 2-Year Frequency			
	Reach 1	Reach 2	Reach 3	Reach 4
Plan 2	10,238 (30.4%)*	6,131 (30.8%)	2,486 (30.9%)	9,868 (30.8%)
Plan 6	13,829 (30.4%)	4,625 (30.9%)	2,292 (30.9%)	9,312 (30.8%)
Plan 7	11,819 (31.1%)	6,617 (31.5%)	2,266 (31.7%)	10,368 (31.4%)
Plan 8	13,237 (31.1%)	8,960 (31.5%)	3,082 (31.7%)	11,730 (31.4%)
Plan 12	9,896 (30.4%)	5,880 (30.8%)	2,367 (30.9%)	9,527 (30.8%)
Plan 13	11,918 (31.1%)	6,931 (31.5%)	2,733 (31.7%)	10,574 (31.4%)
Plan 14	14,021 (31.1%)	9,749 (31.5%)	3,253 (31.7%)	12,199 (31.4%)
Plan 18	9,829 (30.4%)	5,671 (30.8%)	1,920 (30.9%)	9,270 (30.8%)
Plan 19	11,786 (31.1%)	6,488 (31.5%)	2,610 (31.8%)	10,220 (31.4%)
Plan 20	13,281 (31.1%)	8,838 (31.5%)	3,102 (31.7%)	11,659 (31.5%)
Plan 24	9,934 (30.4%)	5,860 (30.8%)	2,359 (30.9%)	9,505 (30.8%)
Plan 25	11,896 (31.1%)	6,910 (31.5%)	2,729 (31.7%)	9,426 (31.4%)
Plan 26	14,169 (31.1%)	9,701 (31.5%)	2,848 (31.7%)	12,170 (31.4%)
Plan 31	10,499 (30.1%)	6,000 (30.2%)	2,415 (30.3%)	9,664 (30.2%)
Plan 32	10,108 (30.4%)	6,014 (30.8%)	2,435 (30.9%)	9,720 (30.8%)
Plan 33	10,187 (30.4%)	6,100 (30.8%)	2,480 (30.9%)	9,850 (30.8%)
Plan 34	10,518 (30.2%)	6,508 (30.4%)	2,618 (30.5%)	10,243 (30.4%)
Plan 35	10,471 (30.2%)	6,448 (30.4%)	2,594 (30.5%)	10,174 (30.4%)

*Estimated actual average cumulative flooding duration. Source of data: CEMVK Hydraulics Staff.

Table 14

Terrestrial Habitat Benefits Derived from Non-Structural Flood Damage Reduction (Reforestation) of Existing Cleared Lands under Various Project Plans, Reach 1, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	7913.28	11350.75	11272.05	6169.16	8260.59	1069.87	46035.70
Plan 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 6	3163.75	4538.07	4506.60	2466.45	6065.17	1445.13	22185.17
Plan 7	3163.75	4538.07	4506.60	2466.45	6065.17	1347.37	22087.41
Plan 8	3163.75	4538.07	4506.60	2466.45	6065.17	1509.02	22249.06
Plan 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 12	7913.28	11350.75	11272.05	6169.16	6556.66	1034.13	44296.03
Plan 13	7913.28	11350.75	11272.05	6169.16	6556.66	1358.65	44620.55
Plan 14	7913.28	11350.75	11272.05	6169.16	6556.66	1598.39	44860.29
Plan 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 18	3163.75	4538.07	4506.60	2466.45	5906.37	1027.13	21608.37
Plan 19	3163.75	4538.07	4506.60	2466.45	5906.37	1343.60	21924.84
Plan 20	3163.75	4538.07	4506.60	2466.45	5906.37	1514.03	22095.27
Plan 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 24	7913.28	11350.75	11272.05	6169.16	6493.87	1038.10	44237.21
Plan 25	7913.28	11350.75	11272.05	6169.16	6493.87	1356.14	44555.25
Plan 26	7913.28	11350.75	11272.05	6169.16	6493.87	1615.27	44814.38
Plan 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 31	3124.79	4482.18	4451.10	2436.07	6993.82	997.41	22485.37
Plan 32	4870.31	6985.94	6937.50	3796.87	6316.35	1056.29	29963.26
Plan 33	8337.97	11959.93	11877.00	6500.25	6618.86	1064.54	46358.55
Plan 34	8337.97	11959.93	11877.00	6500.25	7189.45	999.21	46863.81
Plan 35	6023.60	8640.21	8580.30	4695.97	6993.82	994.75	35928.65

* Assumes that sufficient numbers of maintained and predator-proof nesting boxes will be provided in reforested areas that are flooded from March through May each year.

Table 15

Terrestrial Habitat Benefits Derived from Non-Structural Flood Damage Reduction (Reforestation) of Existing Cleared Lands under Various Project Plans, Reach 2, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	7913.28	11350.75	11272.05	6169.16	4148.11	698.93	41552.28
Plan 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 6	3163.75	4538.07	4506.60	2466.45	3424.15	527.25	18626.27
Plan 7	3163.75	4538.07	4506.60	2466.45	3424.15	817.20	18916.22
Plan 8	3163.75	4538.07	4506.60	2466.45	3424.15	1106.56	19205.58
Plan 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 12	7913.28	11350.75	11272.05	6169.16	3805.75	670.32	41181.31
Plan 13	7913.28	11350.75	11272.05	6169.16	3805.75	855.98	41366.97
Plan 14	7913.28	11350.75	11272.05	6169.16	3805.75	1204.00	41714.99
Plan 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 18	3163.75	4538.07	4506.60	2466.45	3228.52	646.49	18549.88
Plan 19	3163.75	4538.07	4506.60	2466.45	3228.52	801.27	18704.66
Plan 20	3163.75	4538.07	4506.60	2466.45	3228.52	1091.49	18994.88
Plan 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 24	7913.28	11350.75	11272.05	6169.16	3696.46	668.04	41069.74
Plan 25	7913.28	11350.75	11272.05	6169.16	3696.46	853.38	41255.08
Plan 26	7913.28	11350.75	11272.05	6169.16	3696.46	1198.07	41599.77
Plan 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 31	3124.79	4482.18	4451.10	2436.07	4025.53	570.00	19089.67
Plan 32	4870.31	6985.94	6937.50	3796.87	3604.69	685.60	26880.91
Plan 33	8337.97	11959.93	11877.00	6500.25	3863.11	695.40	43233.66
Plan 34	8337.97	11959.93	11877.00	6500.25	4515.22	680.09	43870.46
Plan 35	6023.60	8640.21	8580.30	4695.97	4148.11	673.82	32762.01

* Assumes that sufficient numbers of maintained and predator-proof nesting boxes will be provided in reforested areas that are flooded from March through May each year.

Table 16

Terrestrial Habitat Benefits Derived from Non-Structural Flood Damage Reduction (Reforestation) of Existing Cleared Lands under Various Project Plans, Reach 3, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	7913.28	11350.75	11272.05	6169.16	1642.94	283.40	38631.58
Plan 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 6	3163.75	4538.07	4506.60	2466.45	1379.08	261.29	16315.24
Plan 7	3163.75	4538.07	4506.60	2466.45	1379.08	279.85	16333.80
Plan 8	3163.75	4538.07	4506.60	2466.45	1379.08	380.63	16434.58
Plan 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 12	7913.28	11350.75	11272.05	6169.16	1546.94	269.84	38522.02
Plan 13	7913.28	11350.75	11272.05	6169.16	1546.94	337.53	38589.71
Plan 14	7913.28	11350.75	11272.05	6169.16	1546.94	401.75	38653.93
Plan 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 18	3163.75	4538.07	4506.60	2466.45	1307.23	218.88	16200.98
Plan 19	3163.75	4538.07	4506.60	2466.45	1307.23	347.13	16329.23
Plan 20	3163.75	4538.07	4506.60	2466.45	1307.23	383.10	16365.20
Plan 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 24	7913.28	11350.75	11272.05	6169.16	1498.63	268.93	38472.80
Plan 25	7913.28	11350.75	11272.05	6169.16	1498.63	337.03	38540.90
Plan 26	7913.28	11350.75	11272.05	6169.16	1498.63	351.73	38555.60
Plan 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 31	3124.79	4482.18	4451.10	2436.07	1618.79	252.37	16365.30
Plan 32	4870.31	6985.94	6937.50	3796.87	1450.93	277.59	24319.14
Plan 33	8337.97	11959.93	11877.00	6500.25	1571.09	282.72	40528.96
Plan 34	8337.97	11959.93	11877.00	6500.25	1714.79	273.58	40663.52
Plan 35	6023.60	8640.21	8580.30	4695.97	1642.94	271.07	29854.09

* Assumes that sufficient numbers of maintained and predator-proof nesting boxes will be provided in reforested areas that are flooded from March through May each year.

Table 17

Terrestrial Habitat Benefits Derived from Non-Structural Flood Damage Reduction (Reforestation) of Existing Cleared Lands under Various Project Plans, Reach 4, Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	7913.28	11350.75	11272.05	6169.16	6363.45	1124.95	44193.64
Plan 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 6	3163.75	4538.07	4506.60	2466.45	5608.70	1061.57	21345.14
Plan 7	3163.75	4538.07	4506.60	2466.45	5608.70	1280.45	21564.02
Plan 8	3163.75	4538.07	4506.60	2466.45	5608.70	1448.65	21732.22
Plan 9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 11	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 12	7913.28	11350.75	11272.05	6169.16	6088.72	1086.08	43880.04
Plan 13	7913.28	11350.75	11272.05	6169.16	6088.72	1305.89	44099.85
Plan 14	7913.28	11350.75	11272.05	6169.16	6088.72	1506.58	44300.54
Plan 15	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 17	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 18	3163.75	4538.07	4506.60	2466.45	5434.80	1056.78	21166.45
Plan 19	3163.75	4538.07	4506.60	2466.45	5434.80	1262.17	21371.84
Plan 20	3163.75	4538.07	4506.60	2466.45	5434.80	1439.89	21549.56
Plan 21	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 24	7913.28	11350.75	11272.05	6169.16	5951.66	1083.57	43740.47
Plan 25	7913.28	11350.75	11272.05	6169.16	5951.66	1164.11	43821.01
Plan 26	7913.28	11350.75	11272.05	6169.16	5951.66	1502.99	44159.89
Plan 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 31	3124.79	4482.18	4451.10	2436.07	6294.01	918.08	21706.23
Plan 32	4870.31	6985.94	6937.50	3796.87	5814.59	1108.08	29513.29
Plan 33	8337.97	11959.93	11877.00	6500.25	6156.95	1122.90	45955.00
Plan 34	8337.97	11959.93	11877.00	6500.25	6571.76	1070.39	46317.30
Plan 35	6023.60	8640.21	8580.30	4695.97	6363.45	1063.18	35366.71

* Assumes that sufficient numbers of maintained and predator-proof nesting boxes will be provided in reforested areas that are flooded from March through May each year.

Table 18

Overall Effect of Project Plans on Availability of
Terrestrial Wildlife Habitats across All Four Reaches,
Yazoo Backwater Project

Project Plan	Net Change in Average Annual Habitat Units (AAHU)						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck*	Mink	Total
Plan 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Plan 2	31653.12	45403.00	45088.20	24676.64	20415.09	3177.15	170413.20
Plan 3	0.00	0.00	0.00	0.00	-3406.84	-424.42	-3831.26
Plan 4	0.00	0.00	0.00	0.00	-3406.84	1363.64	-2043.20
Plan 5	0.00	0.00	0.00	0.00	-3406.84	2531.31	-875.53
Plan 6	12655.00	18152.28	18026.40	9865.80	13070.26	2870.82	74640.56
Plan 7	12655.00	18152.28	18026.40	9865.80	13070.26	5088.51	76858.25
Plan 8	12655.00	18152.28	18026.40	9865.80	13070.26	6976.17	78745.91
Plan 9	0.00	0.00	0.00	0.00	-854.18	-257.01	-1111.19
Plan 10	0.00	0.00	0.00	0.00	-854.18	1465.88	611.70
Plan 11	0.00	0.00	0.00	0.00	-854.18	2968.57	2114.39
Plan 12	31653.12	45403.00	45088.20	24676.64	17143.89	2803.36	166768.21
Plan 13	31653.12	45403.00	45088.20	24676.64	17143.89	5323.93	169288.78
Plan 14	31653.12	45403.00	45088.20	24676.64	17143.89	7679.29	171644.14
Plan 15	0.00	0.00	0.00	0.00	-4353.57	-424.42	-4777.99
Plan 16	0.00	0.00	0.00	0.00	-4353.57	1363.64	-2989.93
Plan 17	0.00	0.00	0.00	0.00	-4353.57	2531.31	-1822.26
Plan 18	12655.00	18152.28	18026.40	9865.80	11523.35	2524.86	72747.69
Plan 19	12655.00	18152.28	18026.40	9865.80	11523.35	5117.81	75340.64
Plan 20	12655.00	18152.28	18026.40	9865.80	11523.35	6959.82	77182.65
Plan 21	0.00	0.00	0.00	0.00	-1418.50	-257.01	-1675.51
Plan 22	0.00	0.00	0.00	0.00	-1418.50	1465.88	47.38
Plan 23	0.00	0.00	0.00	0.00	-1418.50	2968.57	1550.07
Plan 24	31653.12	45403.00	45088.20	24676.64	16222.12	2801.63	165844.71
Plan 25	31653.12	45403.00	45088.20	24676.64	16222.12	5176.54	168219.62
Plan 26	31653.12	45403.00	45088.20	24676.64	16222.12	7636.63	170679.71
Plan 27	0.00	0.00	0.00	0.00	-5615.09	-957.10	-6572.19
Plan 28	0.00	0.00	0.00	0.00	-6999.51	-957.10	-7956.61
Plan 29	-618.98	-492.87	-563.95	-657.41	-4147.74	-1367.72	-7848.67
Plan 30	0.00	0.00	0.00	0.00	-5615.09	-957.10	-6572.19
Plan 31	12499.16	17928.72	17804.40	9744.28	19723.55	1817.54	79517.65
Plan 32	19481.24	27943.76	27750.00	15187.48	14400.22	3019.03	107781.73
Plan 33	33351.88	47839.72	47508.00	26001.00	17711.28	3129.86	175541.74
Plan 34	33351.88	47839.72	47508.00	26001.00	24047.07	2688.79	181436.46
Plan 35	24094.40	34560.84	34321.20	18783.88	20710.14	2624.58	135095.04

* Assumes that sufficient numbers of maintained and predator-proof nesting boxes will be provided in reforested areas that are flooded from March through May each year.

Table 19

Estimated Benefits of Establishment of Bottomland Hardwood Forest
Under Various Management Plans, Yazoo Backwater Project

Management Plan*	Increase in Average Annual Habitat Units (AAHU) per 100 Acres						
	Barred Owl	Gray Squirrel	Carolina Chickadee	Pileated Woodpecker	Wood Duck	Mink	Total
				Natural Succession			
MP 1	31.17	24.23	44.40	24.30	0.00	0.00	124.10
MP 2	31.17	24.23	44.40	24.30	60.38	43.05	227.53
MP 3	31.17	24.23	44.40	24.30	60.38	54.09	238.57
				Reforestation with Hard-Mast Trees			
MP 4	31.17	44.71	44.40	24.30	0.00	0.00	144.58
MP 5	31.17	44.71	44.40	24.30	60.38	43.05	248.01
MP 6	31.17	44.71	44.40	24.30	60.38	54.09	259.05

*Restrictions (see text for details):

MP 1 and MP 4 assume that the mitigation site does not flood for more than 25% of the year, and is not located within 328 ft of a lake or stream that contains water more than 25% of the year.

MP 2 and MP 5 apply to sites entirely within 328 ft of a lake or stream. They assume that surface water is present in the adjacent water body for 6 months per year, the site is wet during the March-to-May brood-rearing period, abundant shoreline and over-water cover is present, and well-maintained wood duck nest boxes are provided.

MP 3 and MP 6 apply to sites entirely within 328 ft of a lake or stream containing surface water ≥9 months per year. Other requirements given under MP 2 and MP 5 apply.